Ken Hartman

7835 Processing Procedure.

I.) Pre-installation handling.

1,) Remove 7835 from loading dock and move to storage.

2.) Cut sealing bands, inspect impact sensors for rough handling during shipment and visually inspect tube for damage.

3.) If needed, attach a magnet to the ion pump. Connect tube to an ion pump controller and pump out the tube. Observe vacuum while tube pumps down. Add tube serial number to pump down log sheet and record date.

4.) Until tube is installed in a socket for conditioning, maintain sixty day pump down schedule.

II.) 7835 installation.

1.) Blow out remaining cooling water in old tube using compressed nitrogen.
2.) Center socket under chain hoist.
3.) Unbolt and remove input section. Remove co-axial connector.
4.) Unbolt upper grid plate and remove. Remove ion pump cable, finger sleeve and upper grid water ring.
5.) Unbolt four anode water ports, unscrew water hose flanges from tube and remove port plates.
6.) Loosen upper blocker hose clamp.
7.) Unbolt and remove upper blocking capacitor.
8.) Remove anode connection from tube.
9.) Unbolt and remove upper socket.
10.) Attach top hat to tube and loosen lower blocker hose clamp.
11.) Lift tube with hoist while rotating clockwise, viewed from top of tube.
12.) Remove lower grid water hoses and remove slave cavity from tube.
13.) Remove upper and lower anode connectors from tube.

14.) Replace dead tube in an empty crate.

15.) Remove old spring rings from inner and outer filament busses. Wipe grease off of outer buss o-rings.

16.) Install new spring rings and apply new grease to outer buss o-rings.

17.) Remove a new 7835 from the crate and check anode, filaments and grids for shorted elements using an ohmmeter.

18.) Note lower grid water port orientation and write "In" and "Out" on the anode of the tube.

19.) Inspect inner and outer filament busses for sand, grease, scratches, spring ring marks and burning. Clean as needed to insure a good electrical contact.

20.) Insert inner and outer filament buss spanner wrenches into busses and insure that both busses are tight.

21.) Using both the "7835 Installation Data Sheet" and the 7835 Measurements" procedure, measure both the 7835 filament busses and the socket filament busses and record the results. Perform the error calculations.

22.) If any of the measurements are out of tolerance adjust either the inner or outer socket buss and repeat the measurements until tolerance is achieved.

23.) Install the upper and lower anode connectors on the new tube.

24.) Inspect and grease the o-rings on the lower grid slave cavity and install the slave cavity on the 7835.

25.) Suspend the 7835 over the socket, attach the lower grid water hoses to the slave cavity and leak check the lower grid hoses to 60 psi using compressed nitrogen. If no pressure loss on the gauge is observed after twenty minutes, the test is considered acceptable.

26.) Rotate 7835 counterclockwise 180 degrees and lower tube onto socket filament buss. Once tube is near the spring rings, start turning the 7835 clockwise and pull the excess lower grid hose out of the bottom of the socket. The tube should end up with all four anode water ports aligned over the socket legs and the lower grid "Out" marking on the anode should be centered between the front two anode water ports. **At no time should the 7835 be rotated counterclockwise against the spring rings on the buss! Doing so can damage the spring rings and the filament busses.**

27.) Tighten the lower blocker hose clamp on the lower anode connector spring fingers.

28.) Install and bolt down the upper socket. Attach the anode connection buss to the 7835 anode.

29.) Install the upper blocking capacitor on the upper anode connector and bolt to the top of the upper socket. Install the upper blocker hose clamp over the upper anode connector spring fingers and tighten.

30.) Pressure test the 7835 filament buss water lines as in step # 25 above. Do not exceed 40 psi on the filament busses.

31.) Inspect, clean and grease the four anode o-rings on the anode water hoses. Screw the anode water flanges onto the 7835 and leak test with nitrogen at 60 psi for twenty minutes. If leaks are absent, bolt all four anode port plates on to the socket.

32.) Inspect, clean and grease the two o-rings on the upper grid water ring. Install the water ring and leak check with nitrogen at 60 psi for twenty minutes. Install the finger sleeve and ion pump cable. Install the upper grid plate and bolt to upper blocker.

33.) Install the co-axial connector.

34.) Install the input section and bolt to the upper grid plate.

III.) 7835 conditioning.

1.) Install unconditioned 7835 socket in RF7 in the usual manner.

2.) Connect 7835 as illustrated in "7835 Gas Test Procedure" dated 1/16/90.

3.) Start an entry in the 7835 conditioning logbook for the new 7835. Tape a copy of the "7835 Conditioning" sheet in the logbook.

4.) Set the 4616 screen power to it's lowest value and zero the capacitor bank high voltage.

5.) Turn on the control power for RF7 and warm up the modulator tubes.

6.) Log start time and initial 7835 vacuum reading in the conditioning logbook.

7.) Ramp up the 7835 filament current in "automatic" mode on the filament controller. Record the two vacuum pressure peak readings in the conditioning logbook.

8.) Follow the "7835 Gas Test Procedure" and perform the gas test. Record the data in the conditioning logbook.

9.) Shut off 7835 filament power and reconfigure the 7835 to normal operating setup.

10.) Ramp up the 7835 filament in "automatic" mode on the filament controller, turn on the modulator high voltage breakers and turn on the station high voltage. Perform a capacitor bank crowbar test at 10 kV. Bring up capacitor bank high voltage to 35 kV slowly.

11.) Turn on driver power and look at driver forward and reverse power on the scope. Record driver forward and reverse power as well as 7835 vacuum in the conditioning logbook. Keeping the 7835 vacuum under 50 uA, slowly increase driver power.

12.) Around 100 kW of driver power, adjust 7835 input tuning and input loading controls to maximize driver PA forward power and minimize driver PA reverse power.

13.) Increase 4616 screen voltage until driver forward power reaches 175 kW.

14.) Set coarse attenuator at 8 and fine attenuator at 0.5. Slowly increase the gradient to apply power to the 7835 anode. Keep 7835 ion pump current below 50 uA during RF conditioning. Record Time, Modulator Current, Modulator Voltage, Ion Pump Current, 7835 Power and 7835 Filament Current in the conditioning logbook at regular intervals, noting any trips or unusual observations as well.

15.) Around 1 MW of 7835 output power, adjust 7835 output tuning to maximize forward power and minimize reverse power.

16.) Be careful of modulator blocks and internal tube arcing (indicated by pressure bursts on the ion pump controller) especially at higher power levels. If this happens, reduce power immediately and let tube condition at a lower power level. At higher power levels, increase 7835 filament current to keep the anode voltage below 30 kV to avoid external sparking over the tube ceramic.

17.) Final output power should be near 5 MW depending upon the quality of the tube. Total conditioning time will vary with each individual tube.

SUGGESTED PROCEDURES FOR CLEARING

GRID-TO-CATHODE SHORTS IN RCA-7835

Step (1) Vibration Method

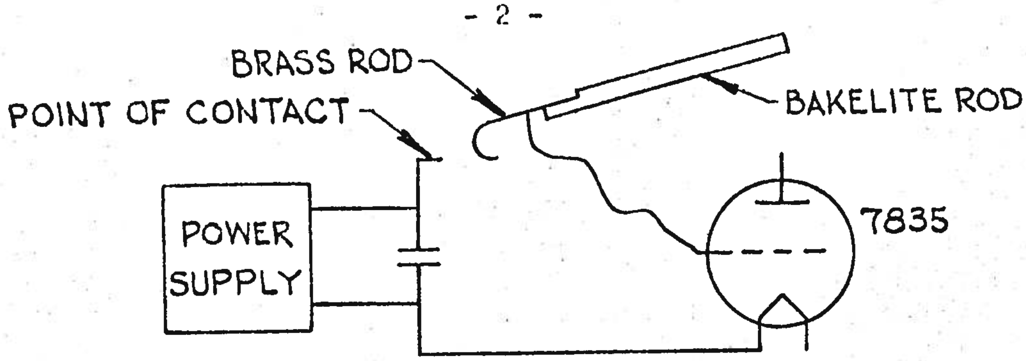
Either place tube in tilt cart or hang by crane such that the tube might be tilted about 10^{o} in different directions. While it is being tilted, tap tube lightly with a rubber mallet (Do not hit ceramic) During this operation, an ohm meter is connected from grid to cathode. If the ohm meter indicates the short clears, continue operation momentarily to see if the short remains clear. If the short can be made intermittent, this type of effort should continue for at least one-half hour in attempt to permanently clear. If the short does remain clear momentarily, the ohm meter should be removed and a voltage hold-off test should be made from grid to cathode. It should hold off at least 1,000 volts. This is best done with a high impedance, variable DC supply capable of supplying 1,000 volts at a short circuit current of 25 milliamps or less. A low impedance supply with appropriate series resistors or a megger can be substituted. The tube should be tilted and tapped with a mallet with this voltage applied to the tube. If arcing or reappearance of the short does not occur, it is reasonable to assume that the tube will now operate.

If the short or low breakdown voltage does still exist, go to Step 2.

Step (2) Apply AC line voltage (105-120 volts AC) through a light bulb from grid to cathode. A variac is recommended but not a necessity. A 100 watt light bulb is recommended. If the short clears, the voltage hold off test should be performed as described above. If the short or low break down voltage condition still exists, proceed to Step 3.

Step (3) The object here is to charge a condenser and discharge it through the grid-cathode short. A maximum energy level of 2.5 joules as calculated from energy in joules equals $\frac{CE^2}{2}$. The preferred equipment for this step is a high impedance power supply as described above and several capacitors such as 1 ufd, 3 ufd and 5 ufd, rated at a minimum of 1,000 volts.

Start with the low value capacitor charged to 100 volts. The idea is to charge the capacitor to the desired voltage before making a connection between condenser and grid-cathode of tube. We use a wire on a bakelite rod as a "switch" and the switch "contact" should be at condenser, or in leads, rather than directly on the tube to prevent burning of the tube as shown in the drawing.



Proceed up in steps of 100 volts to 1,000 volts. Discharge condenser two or three times at each voltage level. If still not successful, follow the same steps with the next size larger capacitor up to 5 ufd maximum at 1,000 volts maximum.

General

The procedure in Step (1) is particularly recommended for a new or rebuilt tube that is received in a shorted condition.

In all procedures strict safety standards obviously must be adhered to for personnel protection. It should be realized that to use methods other than those mentioned above, involving higher values of energy or current, can involve the possibility of permanent damage to the tube and should not be used.

The theroy behind this procedure is based on the fact that most shorts are the result of minute metal particles that become lodged in the close spacing between grid and cathode. These particles can sometimes be shaken loose and into an area where they can do no damage or be burned-out.

E. L. Adams

9-24-70

PROCEDURE FOR R.F. PROCESSING THE 7835

(Taken from Procedure for Installation, R.F. Processing and Operation of the Burle 7835/V1 High Power Triode, Appendix A.)

1/10/90

A vacuum test should be performed on the tube within 30 days of receipt unless it is equipted with an operating ion pump.

> To do this vacuum test, apply 2 KV between the grid and the cathode. A leakage current of < 10 microamps is acceptable.

A vacuum test should be performed on tubes in storage every six months if they do not have an operating ion pump.

Initial 7835 Break-In Procedures.

1. Filament Break-In Procedure.

   Note: the 7835 should be connected in the gas test configuration and the water leakage current can be measured now or after the gas test (step 2) is performed.

   A. ~~Turn the filament on to about 2,000 amps. Allow approximately 5 minutes to elapse before raising the current above the 2,000 amp level.~~

   B. ~~Raise the filament in 1,000 amp (or less) steps every 2 or 3 minutes until 6800 amp typical operating level is reached.~~

   C. ~~Allow the filament to operate at this level for about 15 to 30 minutes without anode voltage or drive power to allow time for the getter to pump any released gas.~~

   <The time for step 1 is about 30 to 45 minutes.>

2. Perform a Gas Test on the Tube. (See diagram page 4).

   A. After the filaments have been operating at full level ~~for at least 5 minutes,~~ apply the -45 volt anode voltage.

B. Turn on the grid supply and adjust for a current of 50 amps dc.

C. Read the gas current on a current meter connected in series with the -45 volt anode supply. This is the initial value.

D. Record gas current values for at least 5 minutes. The 5 minute value minus the water leakage value is the final reading for the tube. A final value of less than 20 microamps is acceptable.

E. Record this number along with cathode voltage and the cathode current.

< Typical time for step 2 is about 15 minutes.>

3. R.F. Drive Break-In Procedure.

Note: The filaments may have to be turned off in order to reconnect the filament resistors and make the tube ready to receive driver power.

A. Apply the R.F. drive at 20 percent of its normal value (35 KW) for about 30 minutes.
Note: If an ion pump is on the tube, one should make sure the ion pump current remains < 100 micro-amps at all times.

B. Increase the drive in 10 percent steps approximately every 15 to 30 minutes until full power is reached.

STEP	POWER	TIME
1.	35 kW	30 minutes
2.	55	15
3.	75	15
4.	95	15
5.	115 KW	15 minutes
6.	125	15
7.	145	15
8.	165	15
9.	175 KW	15 minutes

<Typical time for step 3 is about 2 hrs. and 30 min.>

4. Power R.F. Operation Break-In Procedure.

Note: If at any time during this procedure excessive blocking, crowbaring or arcing should occur,

one should reduce the anode voltage until the tube operation is once again stable.

A. Raise the anode voltage slowly until about 10 amps of peak anode current is reached. Operate at this level for about one hour. 10A/HR

B. Increase the anode current in 10 amp (peak) steps allowing the tube to to operate at each level for about 45 to 60 minutes. Continue this until full power output is obtained. One must periodically check to see if the filament current is set properly for the power being generated.

<Typical time for step 4 is about 20 hours.>

5. Full Power Seasoning.

A. Allow the tube to operate at full power (3.5 to 5.0 megawatt) for at least 48 hours.

B. Make the final log book entry for the operating parameters of the tube at the conclusion of the break-in period. At least the following should be recorded.

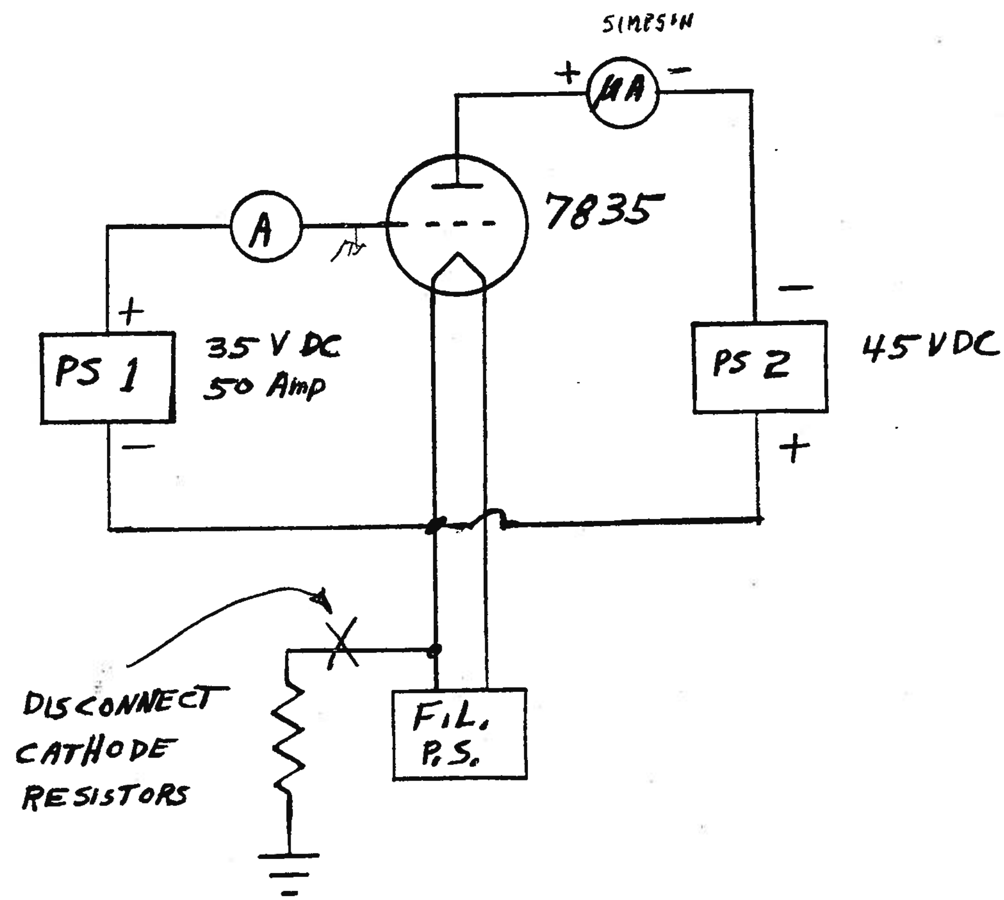
Filament Current
Forward Power
Reverse Power
Anode Voltage (peak)
Anode Current (peak)
Drive Power

<Typical time for step 5 is about 48 hours.>

The Break-In Procedure Approximate Times

Filament Break-In		30 min.
Gas Test		15 min.
R.F. Drive Break-In	2 hrs.	30 min.
Power R.F. Operation Break-In	20 hrs.	
Full Power Operation	48 hrs.	
	===========	=====
Total Break-In time	71 hrs.	15 min.

7835 GAS TEST PROCEDURE
(1/16/90)



Notes
1. Connect the 7835 as shown, making sure the cathode resistors are disconnected. The filament must be floating before PS1 can be turned on.

2. Turn on PS2 (-45 volt supply) and measure the water leakage current with the filament off.

3. Turn the filament on and bring up to normal operating value.

4. Allow the filament to operate for as least 5 minutes to give the getter a chance to remove gas released when the filament was turned on.

5. Turn on PS1 and set to 50 amps grid current. Make the initial gas current reading as soon as possible.

6. After 5 minutes read the gas current value again. The final value to be recorded is the 5 minute reading of gas current minus the water leakage current.
The tube is considered acceptable if the final value is less than 20 microamps.

national accelerator laboratory

7835 INSTALLATION

Russell A. Winje

March 5, 1971

I. Purpose

The purpose of this note is to establish the dimensional requirements relative to mating the 7835 to the PA.

II. Data

Before installing the 7835, make the following measurements on the power amplifier and tube.

1. Dim F - 7835 outer filament connector to the lower mounting surface .650 in., nominal).

2. Dim M - 7835 outer filament length (4 in. nominal).

3. Dim BG - 7835 difference in height, outer filament connector to inner filament connector (0.100 in. nominal).

4. Dim 3 - flange thickness, lower grid cavity 0.500 ~~(0.885~~ in. nominal).

III. Calculations

1. Outer filament pipe.

   Use the following formula to determine the calculated height of the outer filament pipe on the PA above the PA socket tube support surface (Dim 4):

   Dim 4 = Dim M + Dim 1 + Dim 2 + Dim 3 - Dim F - Dim AP

   From the PA and 7835 mechanical data:

   Dim 1 = 1.260 inch
   Dim 2 = 0.125 inch
   Dim AP = 1.650 inch

The permissible range of the difference in the calculated and measured value of Dim 4 is +0.030/-0.060 inch.

If the measured value of Dim 4 is beyond the allowed range, the outer filament pipe must be raised or lowered to bring the measured value of Dim 4 within the allowed range of the calculated value. This can be done by means of shims on the flange of the outer filament pipe located on the bottom of the PA base plate. Record the error.

Also, by shimming, center the outer filament pipe in the PA cavity (±1/32 inch).

2. Inner filament pipe.

Use the following formula to determine the difference in height between the outer and inner filament pipes of the PA (Dim 5):

$$\text{Dim } 5 = \text{Dim } 4 \text{ (calculated)} - \text{Dim AT} - \text{Dim BG} - \text{Dim } 3 + \text{Dim F} - \text{Dim } 6.$$

From the PA and tube mechanical data

Dim AT = 0.875 inch
Dim 6 = 1.889 inch

the permissible range of the difference between the calculated and measured values of Dim 5 is ±0.010 inch.

If the measured value of Dim 5 is beyond the allowed range, the inner filament pipe must be raised or lowered to bring the measured value within the allowed range of the calculated value. Record the error.

The inner filament pipe should be free to move about the PA centerline.

IV. Dimensional Drawing

The dimensions used in this note are shown in the attached figure.

V. Filament Spring Ring

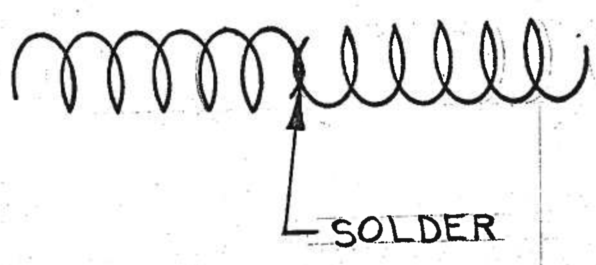
The spring material is silver-plated copper-beryllium; ØD = 0.015 inch.

The spring is wound with a finished OD = 0.135 inch.

The natural length of the spring for the outer and inner connectors is:

Outer:
Inner:

The spring should be connected by soldering a loop made on each end of the spring.



VI. Assembled Tube Elevation

The lower edge of the anode ring must be 15.940 inch above the lower blocker flange.

7835 INSTALLATION DATA SHEET

PA Ser. No.: 7
7835 Ser. No.: P4
Location: System 5
Date: 6/1/71

I. Data

1.	Dim F	.650	inch
2.	Dim M	4.000	inch
3.	Dim 3	.500	inch
4.	Dim BG	.048	inch

II. Calculations

Dim 4 = 3.585 inches

Dim 5 = .923 inch

III. Results

1.	Dim 4 (calc)	3.585	inch
	Dim 4 (meas)	3.545	inch
	Error, Dim 4	.040	inch
2.	Dim 5 (calc)	.923	inch
	Dim 5 (meas)	.923	inch
	Error, Dim 5	0	inch

IV. Seating

Height of lower surface of 7835 anode ring above the lower blocker plate — inch

Burle 7835 Quality Tests

Quick summary of the acceptance test parameters for the 7835 burle tubes

Vacuum test	V_g = 2000 Volts with $I_g < 10$ μAmps

Note: Only for tubes without ion pumps, done within the first 30 days, and every 6 months afterword

Gas Test	Measure I_{leak} of the tube
	I_f = 6800 Amps, V_a = -45 Volts
	Set $V_g \approx 35$ Volts to achieve I_g = 50 Amps,
	$I_a < 20$ μAmps after 5 minutes
Input Resonant Frequency	90MHz < f < 120 MHz
Output Resonant Frequency	240MHz < f < 280 MHz
Upper Grid Pressure Drop	<25 psi
Lower Grid Pressure Drop	<25 psi
Grid/Cathode Pressure Drop	<35 psi
Filament Resistance	(I_f=6800 Amps, $V_f < 4.2$ Volts, $R_f < 0.617$ mΩ)
Plate/Cathode Voltage Cutoff	(I_f=6800 Amps, V_a=35 kVolts, I_a = 5mA, $V_c \approx$ -500Volts)